Semiconductor Based Gas Sensors

Special Topic Seminar

By

Yogesh M. Gulekar

Under the Guidance of

Prof. M. D. Patil

Department of Electronics Engineering

Ramrao Adik Institute of Technology,

Nerul, Navi Mumbai

Motivation

- The existing gas sensors are having many limitations.
- Many types of sensors are available in market but semiconductor based gas sensors are widely used for their various applications.
- The semiconductor based gas sensors have more features than primitive gas sensors.
- They can also be categorized by the type of gas they detect

Outline

1. Introduction
2. Brief explanation of existing gas sensors
3. Limitations of existing gas sensors
4. Advantages of semiconductor based gas sensors
5. Applications

Introduction to gas sensors(IR Gas Sensor)

The essential components of an IR system are:

Source of IR radiation.

Detector capable of seeing the IR radiation.

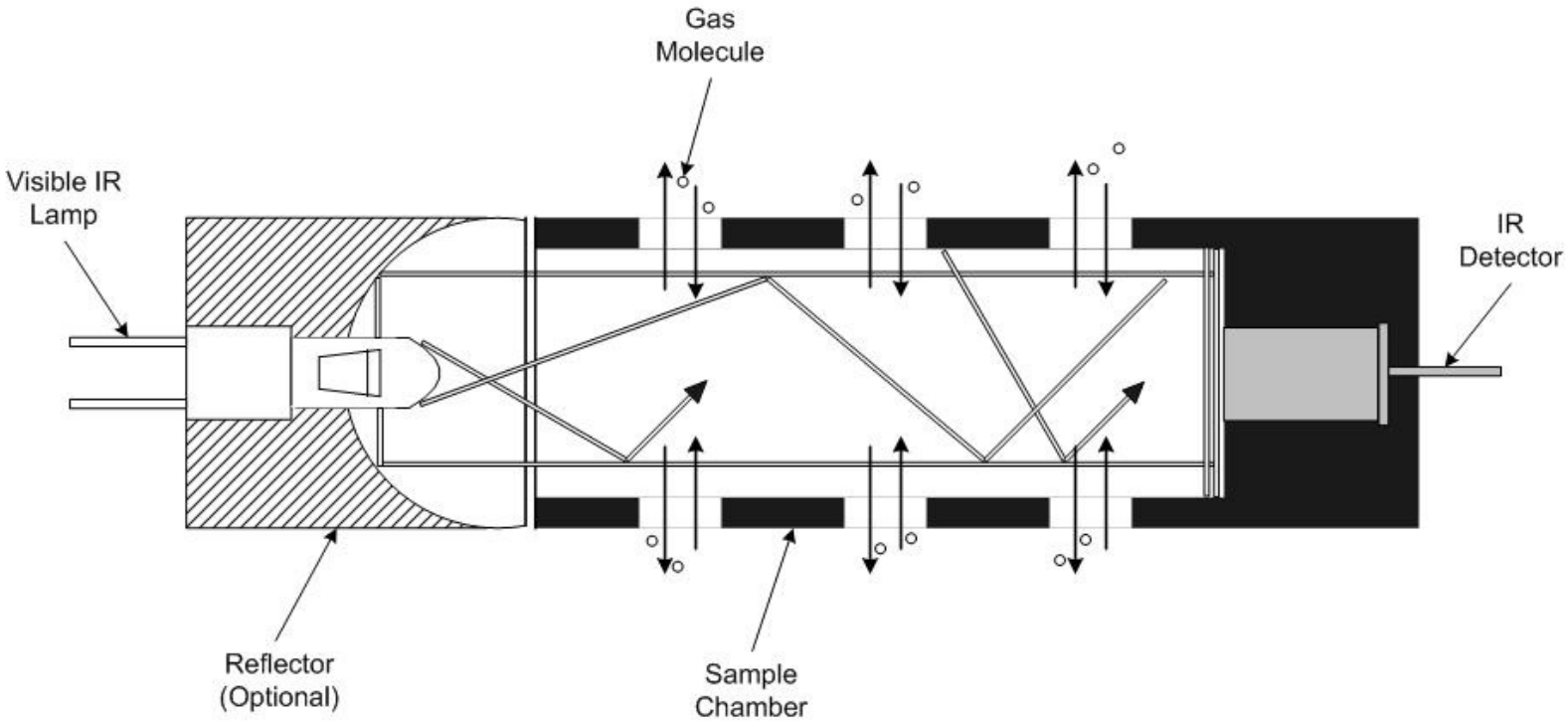
Path between the detector and the source open to the gas to be detected.

Principle:

The detector measures the difference between the dark (no light hitting the detector) and light (full energy hitting the detector)

Introduction to gas sensors

Schematic of Infra Red Sensors



Limitations

- They are not sensitive (need high concentration or long paths)
- They are expensive.
- They are not portable.
- They cannot monitor all gases (only nonlinear molecules)
- They can be affected by humidity and water.
- They can be expensive and dust and dirt can coat the optics and impair response.

Semiconductor Principle

The semiconductor gas sensor is composed of:

Sensing element.

Sensor base.

Sensor cap.

Principle:

When a metal oxide crystal is heated at a certain high temperature in air, oxygen is adsorbed on the crystal surface with a negative charge. A surface potential is formed to serve as a potential barrier against electron-flow which is nothing but the electrical resistance of the sensor material.

Semiconductor Principle

Semiconductor Principle

Relationship

$$R_s = A[C^{-\alpha}] \tag{1}$$

Where: R_s = electrical resistance of the sensor

A = constant

[C] = gas concentration

α = slope of Rs curve

Due to the logarithmic relationship between sensor resistance and gas concentration, semiconductor type sensors have an advantage of high sensitivity to gas even at low gas concentration.

Applications of Semiconductor based gas sensors

Tungsten-Based SOI Microhotplates for Smart Gas Sensors:

Tungsten-based micro gas sensors overcome problems like high cost and high power consumption.
The small size helps in achieving low power consumption, while the use of existing microelectronics technology can greatly reduce manufacturing costs.

Applications of Semiconductor based gas sensors

Tungsten-Based SOI Microhotplates for Smart Gas Sensors

Applications of Semiconductor based gas sensors

Long-term reliability:

The initial tests carried of the long-term reliability of the microhotplates.
Operating at high temperatures for up to 500^0C.
The results during the operation of the large heater at 350^0C.
The heater resistance at this temperature is 180^0C, and it required a current of 10 mA.
At this temperature, the tungsten heaters are extremely stable, with a drift of less than 0.1percent

Applications of Semiconductor based gas sensors

Long-term reliability

Based on PSoC Smart Sensor of Gas Leakage

1. Introduction
2. Principle of Acting
3. Measurement Circuit

Principle of Acting

A gas sensitive element of the sensor is MEMS technology designed.
It is calibrated and sends a warning message if the gas concentration in air reaches the level of dangerous concentration.
It ensures high reliability and operating life of the device.
The Sensor is made practically on one microcircuit with digital interface due to use PSoC.
It provides high accuracy and low prime cost of the device as a whole.

Based on PSoC Smart Sensor of Gas Leakage

Block diagram of smart sensor.

Development of a Wireless Integrated Toxic and Explosive MEMS Based Gas Sensor

- Overall System
- Transmitter Module
- Receiver Module

Overall System

Block Diagram of Overall System.

Transmitter Module

Block Diagram of Transmitter.

Working Principle

Change in the concentration produces a change in the resistance and a constant current source is used which provides constant current that flows through this changing resistance.

Voltage changes across the resistance with reference to the change in concentration.

This changing voltage is provided as a input to the voltage controlled oscillator, the output of this VCO is the variation is frequency which in turn related to change in the concentration.

Concentration is converted accordingly in the frequency variations. As these frequency variations are of low power the RF buffer provides a sufficient gain to these oscillations so that they can be successfully transmitted to space.

Receiver Module

Block Diagram of Receiver.

Thank You...